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OPPORTUNITIES FOR ORGANOSOLV PULPING OF ASPEN

Jairo H. Lora[1]

ABSTRACT.--Organosolv pulping processes offer a lower-capital-cost, environmentally friendly alternative to conventional kraft pulping. Aspen is perhaps the species best suited to this type of processes. The ALCELL® process is an organosolv pulping process that has been tested extensively at the pilot plant level. This process recently advanced to demonstration in a large scale. High quality pulp and useful byproducts can be obtained from aspen by this process. Aspen pulping by the ALCELL® technology is a technically and economically feasible approach to fiber production.

INTRODUCTION

Organosolv pulping is a method of producing bleachable chemical pulp in which organic solvents such as alcohol are used instead of sulfur containing chemicals. The decade of the 1980s has seen a tremendous increase in interest on organosolv pulping processes which have advanced rapidly from the laboratory bench (where they were for many years) to the pilot plant and beyond. This increased appeal is a consequence of the lower environmental impact and lower capital cost of organosolv processes compared with conventional kraft and sulfite pulping.

The chemical characteristics of aspen make this wood an extremely suitable species for organosolv pulping. Its content of lignin (the material that holds the fibers together in wood) is among the lowest of all North American woods. Furthermore, the aspen lignin is more easily fragmented and solubilized under the conditions used in organosolv pulping. Therefore lignin removal and fiber liberation are relatively easy. These characteristics have made aspen one of the favorite raw materials for researchers developing and evaluating different approaches to organosolv pulping.

The ALCELL® process is the organosolv process that is close to commercialization in North America. Aspen has been used widely in the development of this technology. In this paper the application of the ALCELL® process to aspen is discussed.

DESCRIPTION OF THE ALCELL® PROCESS

The ALCELL® process is a patented technology (Diebold et al. 1978, Lora et al. 1988) that has been under development for several years. It is perhaps the simplest approach to organosolv pulping. Considerable attention has been paid not only to investigating pulping conditions, but also to optimizing solvent recovery and byproducts handling. The solvent in this process is typically an alcohol-water solution containing about 50 percent alcohol. When pulping most hardwood species, a catalyst is not required since enough acidity is generated from wood to effectively accelerate the delignification.

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The process has been described in the literature (Lora et al. 1985) and is schematically shown in Figure 1. In the Extraction Section wood chips are initially loaded into an extractor. After preheating with steam the chips are extracted in three stages with countercurrent flow of solvent at around 190-200°C. At the end of the third extraction the relatively clean solvent remaining in contact with the pulp is drained, the extractor is vented and then steam stripped until only trace amounts of alcohol remain. The pulp is discharged from the extractor, screened and sent to the bleach plant.

While the extraction section is batch, solvent and byproducts are recovered continuously. In the Lignin Recovery Section the black liquor obtained in the Extraction Section is flashed, and then diluted to precipitate the lignin. The lignin is recovered by settling, centrifugation and drying. The remaining solution contains alcohol, water and dissolved wood sugars. This stream is fed to the Alcohol Recovery Section, where a distillation tower recovers alcohol for re-use in the process. The stillage from the tower contains the wood sugars, which can be concentrated and spray dried, if desired.

Compared to the kraft process, the simplified ALCELL® process recovery system eliminates the brownstock washer, the recovery furnace, causticizing operations, and calcining operations, and replaces them with a conventional boiler, a centrifuge and a distillation tower.

ASPEN ALCELL® PULP PROPERTIES

Aspen ALCELL® pulps are obtained in yields one or two percentage points higher than aspen kraft pulps. As other hardwood ALCELL® pulps, they are characterized by their easy bleachability. As shown in Table 1 when kraft and ALCELL® pulps with similar amounts of residual lignin were bleached by seven different sequences, ALCELL® pulps consistently resulted in brighter pulps in fewer stages with lower chemical consumption (Lora et al. 1985). ALCELL® pulps are also effectively bleached by sequences that include oxygen stages.

Aspen ALCELL® pulps produced at the pilot plant scale have shown their equivalence to other bleached hardwood chemical pulps for papermaking in a variety of tests. As shown in Figure 2, aspen ALCELL® pulps have better strength than commercial aspen kraft pulps. Because of their strength, optical and surface properties, ALCELL® pulps are well suited for writing and printing paper grades as well as for tissue and dissolving pulp applications.

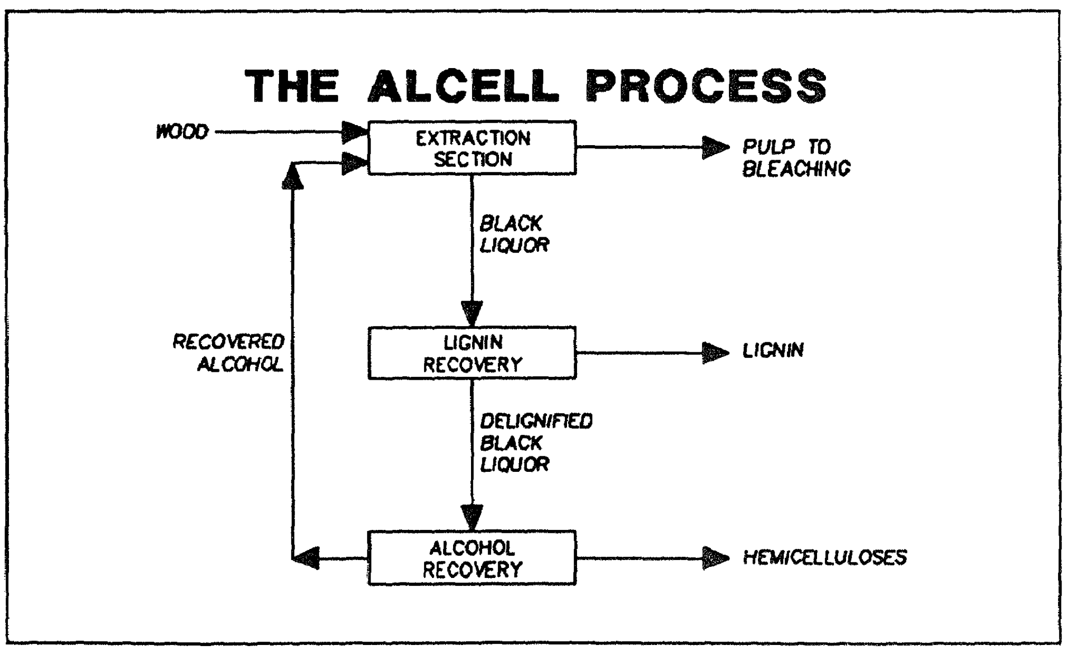

Figure 1.--The Alcell Process.

ALCELL® lignin is a material that resembles quite closely the lignin as it exists in the tree. Unlike lignins obtained from the kraft and sulfite processes, ALCELL® lignins do not contain chemically bound sulfur. ALCELL® lignins are biodegradable and undergo thermal softening at about 140°C. ALCELL® lignin is water insoluble under neutral or acid conditions but soluble in alkaline solutions and in certain organic solvents. It reacts with a number of organic chemicals used in the manufacture of resins and plastics, such as formaldehyde and propylene oxide.

Because of their chemical phenolic nature, ALCELL® lignin has been proposed as a substitute for phenol-formaldehyde (PF) resins. These resins are widely used as adhesives for wood composites and fiberglass insulation and as components of molding compounds, friction materials, foundry core binders and other applications.

Table 1.--Bleached pulp brightness (GE brightness).

Bleach Sequence	Kraft	ALCELL®
CEH	75.6 - 78.8	81.6 - 85.5
CEHD	86.0 - 87.0	87.0 - 90.0
CED	83.8 - 85.5	86.5 - 88.5
CEDED	87.5 - 89.0	89.0 - 90.5
C_DED	82.2 - 86.0	88.0 - 89.5
C_DEDED	87.0 - 88.0	87.8 - 90.2
DED	85.0 - 87.8	86.5 - 89.2

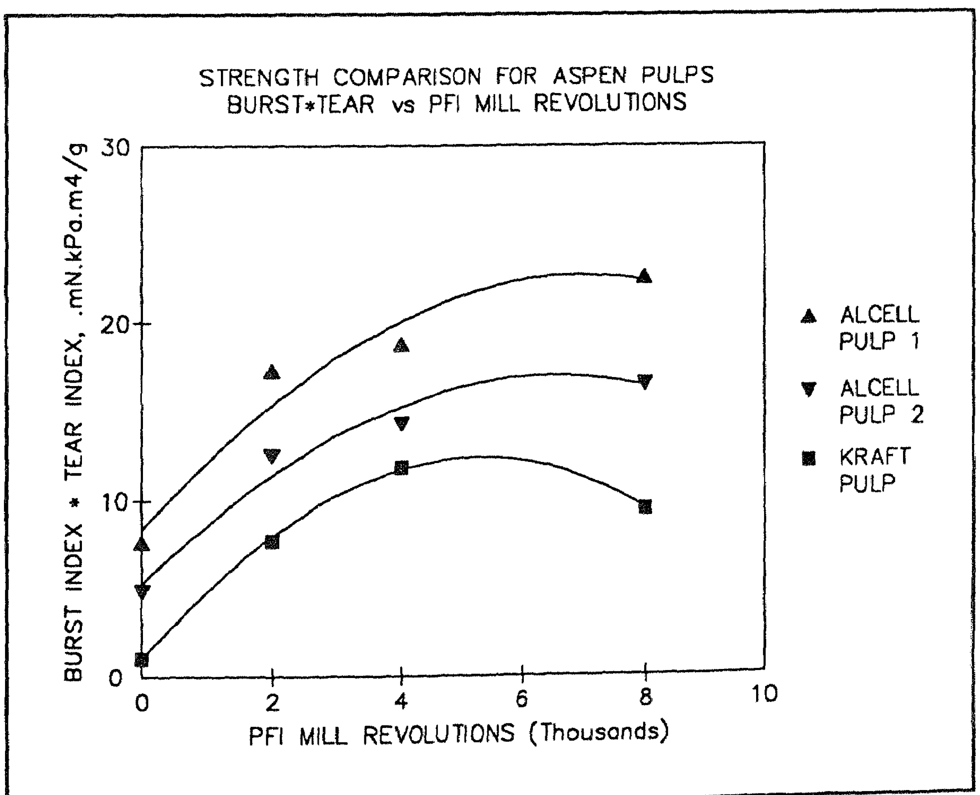

Figure 2.--Strength comparison for aspen pulps.

Most evaluations of ALCELL® lignin as a PF resin substitute have been aimed at the binding of structural wood panels such as waferboard. Earlier laboratory work has indicated the feasibility of replacing about 30 percent of the resin by ALCELL® lignin without deterioration of the board properties (Lora et al. 1989). These results have been confirmed in pilot trials in which 4 x 8-feet oriented strand boards were manufactured using ALCELL® lignin as direct partial replacement of the powder PF resin used in the core (Wu et al. 1989). Boards obtained in these trials were as good as or better than the controls when the level of substitution was 30 percent.

The reactivity of ALCELL® lignin has been used to incorporate it as a component of engineering plastics. An example of this is the use of ALCELL® lignin reacted with propylene oxide in the manufacture of flame retardant foams (Glasser and Leitheiser, 1984).

ASPEN ALCELL® HEMICELLULOSES

The other major byproduct of the process is the hemicellulose stream. In the case of aspen, the largest single component of this stream is a wood sugar called xylose. This can be used for the manufacture of the sweetener xylitol and of the important chemical intermediate furfural. The hemicellulose stream can also be fermented to produce Torula yeast (a food additive), or solvents such as acetone, butanol, 2,3 butanediol, isopropyl alcohol and (although at low concentration) ethanol. Alternatively this stream can be used as animal feed or as a boiler fuel.

CURRENT STATUS

After extensive testing at the pilot plant level the ALCELL® process has started undergoing further development in a larger scale plant located in New Brunswick, Canada. This plant can process batches of wood of about 20 tons (green). It includes complete solvent and byproduct recovery systems as well as pulp processing equipment. This plant started up in the spring of 1989 and has been using aspen as a raw material. The plant has demonstrated that it is possible to produce pulp and byproducts in a large scale by using the ALCELL® process. Current efforts are aimed at process optimization and further research and development.

CONCLUDING REMARKS

It appears that the time is near for this technology to be practiced industrially. The large anticipated demand for paper combined with the environmental and capital cost pressures that conventional chemical pulping processes are facing, could result in a shortage of high quality, high brightness pulps in the near future. The suitability of aspen for the ALCELL® process opens up tremendous opportunities for alleviating fiber shortages in an environmentally friendly manner with reasonable capital expenditures. Since the ALCELL® process is adaptable to small scale, it is conceivable to use it to:

1. Integrate pulp production with paper manufacture.
2. Refurbish sulfite mills that have been closed for environmental and/or economical reasons.
3. Add incremental capacity to kraft mills, especially to those that have bottlenecks in their recovery process.

Furthermore, the utilization of the byproducts from the ALCELL® process results in product diversification which will make a substantial impact on profitability and financial stability.

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